

# Mechanism Independent Cluster Security Services

## BACKGROUND OF THE INVENTION

**[0001]** The present invention is generally directed to providing a consistent interface to security services in a data processing environment which includes a plurality of independent nodes configured into one or more node sets referred to as clusters. More particularly, the present invention provides a multilayer interface which permits the modular inclusion of any number of old or new security protocols.

**[0002]** The IBM pSeries of data processing products include the capability of collecting independent data processing nodes together in an arrangement called a cluster for the purpose of providing application level programs with the ability of employing greater hardware resources in to carry out of their individual processing goals. The use of clusters is facilitated through the use of various operating system level utility programs accessed via defined Application Programming Interfaces (API's). Cluster Services are operating system level services that are related to the operation and administration of clusters. Since the data processing systems of the kind considered herein are typically used simultaneously by a large plurality of disparate users with each user requiring a secure computing environment in which to run, there is a corresponding need to imbue Cluster Services with inherent security protocols.

**[0003]** However, there are many different security mechanisms that can be used and each one of them provides a different API and a different implementation of the Global Services System API (GSS API). Application programmers who write code designed to interact directly with the security interfaces provided by the various security mechanisms and protocols must be aware of the differences in interface and implementation.

**[0004]** This situation has resulted in several problems. For example, customers may have different preferences in terms of the particular security mechanism that they want to use. If a customer wants to use a new security mechanism not originally provided for, cost becomes an

issue since this often means that many other services need to be modified in order to support the new mechanism.

**[0005]** The Cluster Security Services (CtSec) subsystem of the present invention is designed to solve these problems while providing a secure computing environment for the operation of Cluster Services programming. As implemented herein Cluster Security Services exports a mechanism-independent interface for initial acquisition of such items as network identity, client-server authentication, and client authorization. Its use solves two significant problems. First, customers are no longer locked into the use of a particular security mechanism but now may configure their applications to use the underlying security mechanism of their own choice. Secondly, support associated with providing a new security mechanism impacts only one subsystem, that is, Cluster Security Services rather than impacting all of the subsystems in the cluster.

**[0006]** The advantages of using CtSec are several. First, the application program does not need to be aware of how the underlying security mechanism works. Second, there is thus provided an easy-to-use interface that is not changed whenever support for a new underlying security mechanism is desired. Thirdly, this scheme minimizes the number of changes required for supporting new underlying security mechanisms. Additions or modifications are required only in CtSec and not in the applications using it.

## SUMMARY OF THE INVENTION

**[0007]** A preferred embodiment of the present invention provides security services in a clustered data processing environment by first providing a Mechanism Abstraction Layer (MAL) program on at least two nodes of the clustered environment. It is this layer which presents a consistent security interface to applications which run on the nodes. In the present invention, there is also provided at least one security program module, such as KRB5 or PKI, which implements a security service within the cluster. Lastly, there is provided at least one adapter module (Mechanism Pluggable Module (MPM)) for each security program module. The MPM maps parameters of the desired security service to the security interface which is thus now rendered in a consistent manner.

[0008] Accordingly, it is an object of the present invention to increase flexibility in providing security services in a clustered environment of data processing nodes.

[0009] It is also an object of the present invention to reduce the cost associated with adding a different security mechanism to a clustered data processing environment.

[0010] It is a still further object of the present invention to provide a consistent application interface to security mechanisms in a clustered data processing environment.

[0011] It is yet another object of the present invention to enhance the utility and functionality of clustered data processing systems.

[0012] Lastly, but not limited hereto, it is also an object of the present invention to permit application level programs and programmers a greater range in the selection of security mechanisms in clustered systems.

[0013] The recitation herein of a list of desirable objects which are met by various embodiments of the present invention is not meant to imply or suggest that any or all of these objects are present as essential features, either individually or collectively, in the most general embodiment of the present invention or in any of its more specific embodiments.

#### DESCRIPTION OF THE DRAWING

[0014] The subject matter which is regarded as the invention is particularly pointed out and distinctly claimed in the concluding portion of the specification. The invention, however, both as to organization and method of practice, together with the further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawings in which:

[0015] Figure 1 is a schematic diagram illustrating the relations and interactions between and among the multiple layers of components provided in the present invention.

## DETAILED DESCRIPTION OF THE INVENTION

[0016] The Cluster Security Services (CtSec) subsystem, as described herein, provides a secure computing environment within a cluster of data processing nodes. It is structured in multiple layers so that the specifics details of the design of the security mechanism are transparent to the clients. Figure 1 provides a graphical representation of a desired CtSec structure.

[0017] CtSec contains the following three layers: (1) a Mechanism Abstraction Layer 200 (MAL; 200A for Node A and 200B for Node B) which provides security services to clients (100A on Node A and 100B on Node B) who interact directly with MAL Application Programming Interface 150 (MALI, 150A on Node A and 150B on Node B); (2) Mechanism Pluggable Module layer 300 (MPM; 310A and 320A for Node A; and 310B and 320B for Node B) which maps MALI routines 150 to the underlying security mechanism in layer 300; and (3) the underlying security mechanisms themselves in layer 400. These security mechanisms typically include items such as Kerberos Version 5 and PKI. Kerberos is a network authentication protocol. It provides strong authentication for client/server applications by using secret-key cryptography. A free implementation of this protocol is available from the Massachusetts Institute of Technology. Kerberos is available in many commercial products as well. PKI (Public Key Infrastructure) is the combination of software, encryption technologies, and services that enables enterprises to protect the security of their communications and business transactions on the Internet. PKIs integrate digital certificates, public-key cryptography, and certificate authorities into a total, enterprise-wide network security architecture. There are several vendors who sell PKI products, including Verisign, RSA, IBM, amongst others. All of these layers work cooperatively to provide authentication and authorization services to CtSec clients (100A and 100B).

### MAL and Its Interface (MALI)

[0018] MALI (layer 150) provides generic authentication and authorization routines and mechanism independent Access Control List (ACL) management services. MALI is designed to mask the complexity of the underlying security mechanism and to also mask differences in the

interfaces (API's) and the disparate implementations among different security mechanisms. Most of the MALI routines (except for the ACL manipulation routines) in turn call routines exported by loaded MPM's. Multiple MPMs are loaded at one time and MAL determines which MPM to use based on the cluster security setup and also on the negotiated mechanism. It is the application's responsibility to negotiate the security mechanism to use between the cluster application client and the cluster application server by using dedicated MALI routines. Once a security mechanism is negotiated, the MAL selects the appropriate MPM (if it exists), loads it into memory (if it is not already loaded) and calls the routines exported by the MPM (if they are exported by MPM layer 300). Failure in any of these steps results in failure of the MALI routine.

[0019] ACL management service is provided by MAL 200 to allow servers to enforce discretionary access control based on ACLs. ACLs contain one or more entries. In preferred embodiments, each ACL entry is defined by type (for example: user, group, "authenticated by" mechanism, authenticated, unauthenticated), mechanism (not used for entries of type unauthenticated or authenticated), id (identifier used for user and group entries), and permission bit mask. The ACLs are opaque to the cluster application (100A or 100B) and they are treated like data buffers with length and body. In one release of the cluster security services, ACL storage is left to the discretion of the application. In other releases, CtSec provides an ACL storage facility that cluster applications use.

### MPM and Its Interface (MPMI)

[0020] MAL modules (200A and 200B) are an abstraction of the security mechanism in layer 400, and do not make any distinction between different security mechanisms. MAL 200A and 200B use MPM modules 250A and 250B, respectively, to convert the data supplied by the application into the specific data format expected by the security mechanism. Each MPM module exports a set of routines that create the desired MPMI. These routines are implemented using each security mechanism's API and they are called by the MALI routines. MAL 200 uses the pluggable module mechanism to determine which MPMI routines to run. This plug-in mechanism determines which underlying security mechanism is to be configured for use

between the client the server, and loads the corresponding plug-in into the process memory space. Then it determines the address of the routine it needs, calls it and passes the specifically correct arguments.

[0021] MAL uses a synchronization mechanism to control access to the plug-in code. The synchronization is implemented with single-write/multiple-read locks and allows for unloading of the plugged-in module whenever the underlying security mechanism runtime supports dynamic unloading.

### Data Manipulation

[0022] CtSec isolates the client from all of the details pertaining to the underlying security mechanism and it does not export data structures that are specific to the mechanism. CtSec clients deal only with generic buffers and pointers (handles to tokens), and they are not aware of the data structure they represent or point to.

[0023] The processing of data is done at two levels: MAL 200 processes only the mechanism independent data, and each MPM in layer 300 processes mechanism-specific data. MALI routines rely on MPMI routines to do the "real" work. For example, MAL is responsible for the following: reading security configuration, loading and initializing MPMs, keeping track of each MPM's state, synchronizing access to global data, manipulating ACLs and enforcing access control based on a text representation of the client's identity. MPMs are responsible for the following: acquiring initial credentials, initiating and accepting security contexts between clients and servers, allowing servers to impersonate clients and translating mechanism-specific client identities into printable strings.

[0024] While the invention has been described in detail herein in accordance with certain preferred embodiments thereof, many modifications and changes therein may be effected by those skilled in the art. Accordingly, it is intended by the appended claims to cover all such modifications and changes as fall within the true spirit and scope of the invention.